STRATEGY RESEARCH PROJECT

THE EVOLUTION OF ARMY C⁴ ACQUISITION

BY

COLONEL THOMAS R. NOREEN
United States Army

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Colonel Thomas R. Noreen

Colonel Ralph D. Ghent
Project Advisor

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ABSTRACT

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With the continual growth in technology, smaller force
structures, and the shrinking procurement budget the way we
acquire C^4 equipment must change because the current system is
inadequate to met the needs of the warfighter. The purpose of
this paper is to determine whether the acquisition system has
ever been able to take the dictates of doctrine, the warfighter's
needs, and advances in technology and transform them into a C^4
product that enables and enhances command and control. Taking
the lessons learned from tracing the evolution of the research,
development and acquisition (RDA) of C^4 systems from the pre-
World War II years to the present, we can then make
recommendations for improving the system in the future.

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*Improved interoperability, greater reliability, and
enhanced security—achieved through rapid advances in
information technology—are essential for effective
command and control as we enter the 21st Century.
Automated information systems and networks provide the
predominant source from which the warfighter generates,
receives, shares, and utilizes information. The
synthesis of advanced C^4 capabilities and sound
doctrine leads to battlespace knowledge essential to
success in conflict.*

> — General John M. Shalikashvili, USA Ret.
> *Joint Pub 6-0*

ARMY C^4 ACQUISITION — WHAT IS IT?

Acquisition is an all-encompassing term that covers any
military system's existence from preconception to grave. An Army
system begins its life as a soldier's perceived need of a better
way to accomplish the task at hand. Changes in doctrine or
advances in technology can also drive the requirement for a new
system. That need, if validated and approved by the Army's
leadership, then takes on a life of its own as it begins its way
through the bureaucratic acquisition management process.

The focus of this paper is on the acquisition of U.S. Army
Command, Control, Communications and Computer (C^4) systems.
These C^4 systems are broadly defined as,

Integrated systems of doctrine, procedures, organ-
ization structures, personnel, equipment, facilities,
and communications designed to support a commander's
exercise of command and control across the range of
military operations.[1]

C^4 systems are designed to enhance a commander's ability to
execute the mission. These systems become more critical as the
speed and lethality of battle increase as we fight simultaneously

over extended distances in multiple locations. The need for a flexible, responsive acquisition system, which supports the warfighting commander, is paramount.

Bureaucracy and the budget are external factors that have influenced the acquisition process the most. Bureaucracy governs the rules for the acquisition process. Factors such as defense re-organization, Congressional involvement, and defense regulations influence bureaucracy. The defense budget approval cycle and approved funding levels define budgetary issues. Over time, these two factors have shaped the acquisition system into what it is today. To see the impact of these forces on whether the process has supported the warfighter, it is necessary to examine them at various points in history.

World War II provides an excellent starting point for this evaluation process. Before World War II, command and control communications were still a function of the leader issuing orders directly to his subordinates. The key electrical systems used in World War I were the telegraph and telephone. Radio communications were unreliable, oversized, and generally not effective. World War I radio capabilities were primarily limited to Morse code and used as backup to wire communications.[2] Other critical time periods include the Korean Conflict, the early Cold War era, Vietnam Conflict, the post Vietnam period that includes *Urgent Fury* and *Just Cause* and post Cold War operations such as *Desert Shield/Storm, Restore Hope* and *Operation Joint Endeavor.*

This paper will examine each of these eras with a focus on how well the C^4 acquisition process supported the warfighter.

Currently "major defense systems may take from 12-15 years from identification of a deficiency (or technological opportunity) to fielding of a system to satisfy the requirements."[3] At the same time, Moore's Law, the publicly accepted value for advances in electronics, states that the technology turnover rate is about 18-24 months. "The current defense acquisition system with its complexity and endemically long cycle times hinders exploitation of this huge global source of new commercially-developed technologies."[4] Given this paradox, can the current acquisition process meet the requirements to "leverage technological opportunities to achieve new levels of effectiveness" and attain information dominance?[5] The real question is not whether the acquisition system will support the Army 2010 but whether it has ever supported the research, development, and acquisition (RDA) of Army C^4 systems.

THE ACQUISITION MANAGEMENT SYSTEM

The current acquisition process follows a very set and formal procedure that has evolved over time. A diagram of that process is found in Figure 1 below. In an examination of today's process or that of World War II, the key phases are the same. In the next section the effects of bureaucracy and budget on the process will be examined. However, first it is necessary to view

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the process as it stands today. The following paragraphs

illustrate the basics of the acquisition process.

Initiation of the process can result from the determination

of a user requirement, a change in doctrine, or from a new

technology that has been developed either in the U.S. Army

laboratory system or in industry. In any case, the requirement

must be validated and approved at Milestone 0.
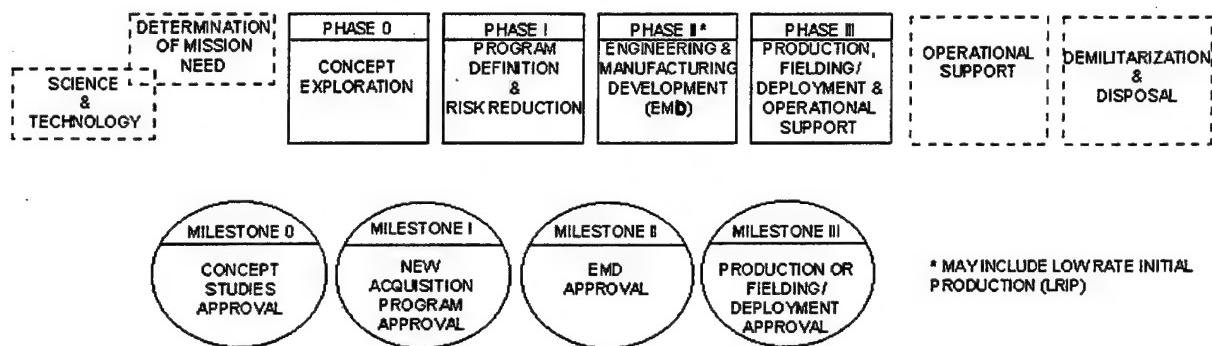
Figure 1: Acquisition Milestones and Phases[6]

Once the concept is approved and funding is provided a

feasibility study is conducted during Phase 0, Concept

Exploration. Milestone I approval provides access to Phase I

where the system undergoes formal development and risk reduction.

Prototypes may be built and tradeoffs in cost and performance are

made with the goal of reducing risks to the lowest possible level

while at the same time meeting the user's needs. A Milestone II

approval lets the program progress to Phase II, Engineering and

Manufacturing Development (EMD).

During EMD actual production engineering takes place

resulting in the manufacture of initial production models.

Technical evaluators and operators test the systems during this phase to see if they meet technical requirements and user needs. Systems that pass Milestone III are permitted to enter Phase III, Production and Fielding.

The final part of the process is maintaining the system in the field, updating it, and then eventually disposing of it once it becomes obsolete. As stated earlier, for a major system this entire process can take from 12-15 years from the time the need is identified until it is fielded.

Proven technology, existing commercial-off-the-shelf (COTS) products, and non-developmental items (NDI) can significantly reduce the length of time needed to field a system. However, even programs structured around COTS and NDI components can still take two to four years to field. Requirements for operational testing, formal Milestone approvals, and logistical support requirements extend the cycle.

Parallel to the system development is maintenance of the funding stream. Keeping money in the budget is as difficult as developing the system itself. A product or project manager (PM) must continually guard and monitor available funds.

C4 SYSTEMS ACQUISITION - THE JOURNEY

The following sections look at how effective the acquisition process was at transforming doctrinal changes, technological advances, and user requirements into usable systems. At the same

time, we will explore the impact of bureaucratic and budgetary changes on the evolution of the acquisition system.

WORLD WAR II

World War II ushered in two new developments in war for America. For the first time in our history, the requirements of war touched all facets of our daily life with a total mobilization of resources and people.

Technology changed the way the services fought and thought. Air power could now bring the war into the depths of the enemy's homeland with strategic bombing. The Navy could project its air power from aircraft carriers and the Army and Marines perfected amphibious operations. Technology also extended the eyes and voice of the commander through the development of radar and new communications systems.

Prior to World War II "the attributes of the Signal Corps mission were largely administrative and the equipment required to carry it out was therefore likely to be of commercial or near-commercial models."[7] The equipment supporting this mission consisted primarily of telephone, telegraph, and teletype. During the war these means of communication still provided the backbone for the vast majority of the information transmitted from corps level and above. However, at the tactical level new advances in technology brought radio out of the back of a truck and put it into the hands of the commander.

At the outbreak of World War II, "General Marshall specifically ordered General Olmstead to do two things: To co-ordinate Army communications and to decrease the number of types of radio sets in use."[8] General Olmstead accomplished the first task. He never accomplished the second as user requirements were one of the two primary inputs into the acquisition process. The second major driver was new technology.

The acquisition system was shaped and primed prior to the war. The Signal Corps laid the groundwork for wartime procurement of signal related equipment during the 1930s when it took on the "responsibility of setting up the machinery by which the productive capacity of the U.S. might be converted with a minimum of delay into an Arsenal of War."[9] This initiative coupled with the Lend-Lease Act both helped to expand the industrial base and at the same time provided an operational test capability of the equipment by foreign users. "There is no laboratory like the field of battle and for months before the first American shot was fired, it was possible for officers to see how their equipment fared in actual combat."[10] This process provided an iterative means to correct system deficiencies.

New technology played a key role in the decision on which radio systems the Army would develop. In addition to "developing and procuring radar, a totally new electronic weapon,"[11] the Signal Corps made "the decision to gamble on new FM [frequency

modulated] and crystal-controlled radios"[12] rather than going

with the amplitude modulated (AM) radios initially developed

during World War I and then improved during the inter-war years.

The Signal Corps did this for three reasons. First, these radios

could be made smaller, lighter and more rugged. Crystal

controlled FM radios were also easier to operate and took less

power. Finally, they provided superior transmission quality as

compared to their AM counterparts. This introduced an entire new

family of radios into the inventory while at the same time AM

radios were still being maintained for long distance

communications.

During World War II, the user had a great impact on the

development of radio systems. Each combat arm, to include the

Army-Air Force, wanted radios specific to its needs. Thus, "far

from achieving the reduction of radio types that General Marshall

had demanded of General Olmstead in 1941, the Signal Corps had

developed many new special-purpose sets in response to demands

from the using arms."[13]

The World War II acquisition system was much more

streamlined than now. The Signal Corps could take its

requirement directly to industry skipping directly to Phase II.

The manufacturer did the technical testing, the Signal Corps

managed the money, and the user verified its capability. An

example of this was the Infantry's request for a short-ranged

radio. Within three months of the request,

The Galvin Corporation demonstrated equipment which filled the bill. Weighing only five pounds, the Army promptly accepted in substantially its original form. It became the SCR-536 and probably the best-know item of all Signal Corps equipment in the war: the handie-talkie.[14]

During World War II the functions of technology and warfighter requirements determined which communications items were procured. The warfighter had a direct route to the Chief Signal Officer and only had to convince the Signal Corps of the need and provide money. If the Signal Corps laboratories did not have a materiél solution for the need, it could be directly passed to a Signal Corps contracting officer in one of the four War Department Zones.[15] This resulted in the proliferation of communications equipment which met the warfighter's needs.

As stated above, the RDA process was simpler, more efficient, less bureaucratic than today, but not necessarily cost effective. There were no checks and balances on the system.

KOREA

The principle driver of the acquisition process during the Korean War was technology. The RDA process had changed little during the inter-war years; however, some small modifications in contracting were made. Even though the nation was not mobilized, the process remained streamlined enough to support rapid wartime production.

During the years following World War II, "nearly every major piece of Signal equipment had been redesigned or was undergoing

substantial modifications."[16] In the process of doing this, we decreased the number of fielded systems which, in turn, reduced many of the maintenance and logistical problems that come with a proliferation of systems. The Signal Corps used the knowledge and experiences of World War II to prepare for the future by conducting the research and initiative needed to keep pace with technology.

> Upon the onset of hostilities in Korea, all-out efforts centered on production engineering of equipment designed after World War II. By 1952, 250 out of 274 pieces of major signal equipment moved to field use were either new or improvements over their predecessors.[17]

The Signal Corps leadership felt that the capabilities that these improved systems would bring to the warfighter far outweighed any difficulties encountered in their production.

Going back to Figure 1, this meant that the Signal Corps had already completed Phases 0-II of the acquisition cycle so the majority of this equipment was either already in production or ready to move into that phase.

To enhance this transition, the Signal Corps added the "leader-follower" concept to its contracts so that the prime contractor was responsible for assisting the "follower" contractor in the production of the system.[18] Additionally, "contracts were let for combined development-production, whereby, the manufacturer immediately followed the developmental state with full-scale production."[19] Each of these facilitated the

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manufacture and fielding of systems needed to support the Korean Conflict.

During the conflict, commanders placed a greater reliance on very high frequency (VHF) FM radios than on wire even though wire was doctrine. This happened because "distance, speed and road nets limited the use of wire."[20]

In the Korean era, the Signal Corps also led the way in basic research with the development of new technologies. Among these technologies was the transistor. Bell Telephone first created the transistor in 1948 as a replacement for the power-hungry vacuum tube. However, commercial industries saw no reason to invest in this new technology, as size was not an issue with consumer products.[21] The Signal Corps was concerned with the size, weight, reliability, and power consumption of the systems it developed. The Corps,

> In conjunction with electronics industry, in particular Bell Laboratories, facilitated the creation of this revolutionary device. During the 1950s the Signal Corps subsidized much of the research and production costs.[22]

The acquisition process remained relatively simple with the Signal Corps in control of both what was being made and the budget. Because the Signal Corps had invested in the development of new systems and technology in the post World War II years, they had systems ready to field. The RDA process supported the Korean War commander with high quality, mobile, and interoperable communications systems. Some of these systems, such as the GRC-

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26 Radioteletype, were still in use twenty-five years later when the author came on active duty.

DETERRENCE AND THE COLD WAR

With the proliferation of nuclear weapons in the post-Korean era, the face of war changed. The United States could no longer afford to field and maintain a large standing conventional army while at the same time concentrate on the fledgling nuclear arms race with the Soviet Union. "The Eisenhower administration's strategy of deterrence created strong incentives for the Army to organize itself to prevent wars rather than fight them."[23] However, this opinion was not held by all. "Ridgeway resisted that inclination, 'The Army exists for the single purpose of victory in battle and success in war.' "[24] The question that required an answer was how could the Army survive on a nuclear battlefield and then go on to victory?

The Army's solution to this problem involved the creation of "combat units with greater depth, mobility and flexibility"[25] that would be dispersed over a greater battlespace. "The Army christened this new structure the Pentomic Division."[26] The dispersion that was envisioned by the Pentomic Division allowed commanders "more options for deploying forces in depth or for dispersing them to fight in all directions on a 'non-linear' battlefield."[27]

This doctrinal and organizational change had a great impact on the Signal Corps and the way it was organized to support the division commander and his subordinates. In an effort to accomplish this mission, "the Signal Corps combat development program was initiated in 1954 to provide improved and new combat capabilities for the Army."[28] No longer would the lines of communication follow a linear path along the division's axis of advance. "A new idea in communications doctrine was to establish an area 'grid system'"[29] which "provided a basic network of communication facilities spread over an operational area."[30]

To meet this challenge, "the mission, scope and technical programs of Signal R&D almost doubled."[31] The results of this R&D effort were highly mobile systems that could be reconfigured based on the tactical situation for use at all levels of command.[32]

New technology was incorporated into the design of much of the new equipment whenever possible. Some of the equipment designed during this period is still in the Army inventory. The most familiar of these systems is the AN/VRC-12 family of VHF FM radios that was originally fielded in FY59.[33]

To ensure that these new systems would work both physically and doctrinally, a new "electronic test facility, which would provide for duplicating all communications-electronics equipment in a Field Army with all elements dispersed"[34] was designed and

built at Fort Huachuca, Arizona. "The U.S. Army Electronic Proving Ground was recognized by the Army as a major contributor to the Army's over-all combat development program."[35]

There is no doubt that doctrine played a pivotal role in the development of new communications systems during the initial Cold War period. No longer could a single, signal company support a division. In order to cover the dispersed area a battalion was now required.

Concurrent with the changes in doctrine; advances in technology also played an important aspect in the RDA and improvement of communications equipment. The full impact of the transistor and miniaturization were being felt. Outside the tactical area, the Signal Corps was playing a leading role in the development of guidance and target acquisition systems for guided missiles[36] and in the launch of the first communications satellite in 1958.[37]

The acquisition process of the early Cold War era differed little from that of the Korean War. The Signal Corps ran the system and had the authority to allocate available funds where needed. Even though there was a great reduction in conventional force structure, funds were available for the procurement of communications systems. The systems fielded met the needs of the new doctrine and supported the war fighter.

THE VIETNAM ERA

As the Nation entered the 1960s and the Kennedy administration, the clouds of conflict were again on the horizon. The way the Signal Corps developed and acquired communications equipment changed tremendously during the Kennedy era as the Signal Corps was divested of the RDA responsibilities and additional bureaucratic and budget constraints were placed on the "new" RDA system.

The Vietnam Conflict brought change to the equipment developed. Doctrine, warfighter needs, and technology all played key roles in determining what systems were developed and fielded during Vietnam. The "new" RDA process did not support the development of this equipment as well as the earlier one had.

Secretary of Defense McNamara "believed that the Army had to be made more efficient and more fiscally responsible to survive in the modern technological era."[38] This prospect of reorganization did not bode well for the Signal Corps.

> By 1960 the Chief Signal Officer had become one of the most powerful men in the Army. As head of the third largest branch in the Army, he was responsible for all aspects of Army communications: doctrine, personnel, logistics, staffing, and operations. His span of interest embraced such esoteric endeavors as missile guidance, battlefield surveillance, data processing, satellites, and night vision.[39]

Under the direction of Secretary McNamara, "Project 80 had been planning a reorganization of the technical services along functional lines."[40] This coupled with a "growing uneasiness in

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both the executive and legislative branches of Government over the Government's ability to manage and control its massive defense effort, particularly in the spectacular area of R & D"[41] rang the death knell for the technical services. President Eisenhower warned of this same issue in his farewell address when he said, "in the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex."[42]

On 17 February 1962 the reorganization of the Army took effect. Functional commands took over a majority of the responsibilities of the technical services. The Signal Corps lost its RDA mandate to the newly established Army Materiel Command (AMC). The Signal Corps even lost its home at Fort Monmouth to AMC's Electronics Command (ECOM) which took over the Signal Corps RDA functions.[43]

In March 1964, 104 years after the birth of the Signal Corps, the Office of Chief Signal Officer was abolished. A Chief of Communications-Electronics provided staff advice to the Army Staff and a newly created Strategic Communications Command (STRATCOM) took charge of the Army's part of the Defense Communications System (DCS).[44] This further fragmented the responsibilities for C^4 in the Army.

Under this reorganization, the Signal Corps no longer had direct responsibility for the development of the equipment it

would use or be responsible for. In 1964, the Army established a new Combat Developments Command (CDC).

> Combat Developments Command would now determine characteristics and capabilities in concert with organization, tactics and battle environments. AMC [ECOM] has the responsibility for controlling all Army wholesale materiel operations from development through production to supply.[45]

While Signal Officers were involved in both the combat development process and RDA, no longer was there a single advocate within the Signal Corps. The Chief of Communications-Electronics, as an Army Staff Officer, did not carry the clout that the Chief Signal Officer did when dealing with either the staff or major commands such as AMC and CDC. A system of checks and balances had been initiated.

The Department of Defense decision to adopt the Program Manager (PM) concept in 1965 also impacted on the RDA process. Now a single individual had the responsibility of bringing a system from need to the field.[46] However, this individual had to please multiple masters and work through an ever-growing bureaucracy. Harvard University trained senior PMs and commercial sector executives in a three-month Advanced Management Program.[47]

In conjunction with the Army's reorganization of its technical services an independent testing command was established. The Test and Evaluation Command stood-up in 1965 with the responsibility of testing new items to make sure they

met the Army's requirements and the contractor's claims.[48] Prior
to this, the tests conducted in Phases II and III of Figure 1 had
been primarily the responsibility of the contractor and the
Signal Corps.

Further constraining the contracting process was DOD's
decision to make competitive contracting the norm. No longer
could the Army pick a firm on a sole-source basis even though it
often meant shorter procurement times and better quality
equipment.[49]

The Army's reorganization in the 1960's significantly
changed the RDA process of C^4 systems with the break-up of the
Signal Corps monopoly of the system. This "fragmentation" in
turn caused the time for the RDA of a system to increase.

Referring back to Figure 1, the Combat Developments Command
now determined whether there was a need for a new system. The
ECOM labs of AMC controlled the basic research and exploration of
new technologies along with the initial phases of concept
development and program definition. Transition to the new PM-run
program took place once the program was approved.

Requirements for competitively bid contracts and independent
testing of new systems also increased the time it took to field a
system. Layered on top of these changes was the new budgeting
process created by McNamara.

Thus, not only did a PM have to satisfy a "user" from CDC, a
"tester" from TECOM, and the constrained requirements of his

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competitively bid contract but he also had to fight for his budget. While not fully fleshed out, this acquisition process of the 1960s had evolved into one readily recognizable by today's standards. Gone were the days when a contractor could design and field a radio in a matter of months.

At the same time the Army was reorganizing its technical services, it was also changing its basic warfighting force structure and doctrine. The Pentomic Divisions were not strong enough for conventional war and not flexible enough for the new flexible response strategy proposed by the Kennedy Administration. The new Reorganization Objective Army Divisions (ROAD) were larger, more mobile and required a larger Signal Battalion to support a division's operational area of up to 200 square miles. The new organizations did not initially have an effect on the type of equipment employed, only on the quantity needed to fill these increased requirements.[50]

The Vietnam Conflict did impact on the need for command and control communications which could span the globe. "Tactical decisions once made in the field were being made in the Pentagon or even the White House, blurring traditional distinctions between tactical and strategic communications."[51] Commanders, just as now, wanted the same C^4 capabilities in the field as in garrison. The first satellite communications system used in a combat theater, linking Hawaii and Vietnam, was installed in August 1964. A backbone, commercial quality troposcatter

communications system linking major cities in Vietnam with Thailand provided strategic communications within the theater of operations.[52]

The equipment that the tactical units took to Vietnam was essentially the same as developed for Korea. The ECOM labs were working on a newer generation of "transistorized" equipment such as the PRC-77, which would replace the PRC-25, and the GRC-122/142 which were follow-ons to the GRC-26. These new systems would see extensive use during Vietnam. Less extensive use was made of improved multichannel terminals. These new Army Area Communications System terminals were not available until late in the conflict because the RDA system was not flexible enough for accelerated development and production.[53]

The Vietnam era brought the greatest changes to the acquisition system. These changes were a major turning point. The streamlined system that had supported the warfighter so well was now a bureaucratic nightmare that was unable to bring major communications systems to the field in a timely manner.

POST VIETNAM

During the post Vietnam time frame of the early 1970s to late 1980s the major factor effecting the acquisition process was an attempt at bureaucratic reform. The Army, followed by the President and Congress, made attempts to streamline the process and make it more efficient.

As in the Vietnam era, doctrine, warfighter needs and technology all played major roles in determining what C^4 equipment was developed and fielded. The microprocessor became a reality in the mid-1970s with the introduction of large-scale integrated circuits (IC). These ICs made it possible to build smaller, more reliable electronic components. The Army's new Airland Battle doctrine identified the need for even more mobile and less manpower intensive communications systems.

The increased bureaucracy of the 1960s did not go unnoticed. In December 1973, the Secretary of the Army established the Army Materiel Acquisition Review Committee (AMARC). This committee was chartered to develop new procedures to improve the RDA process. The committee recommended in its April 1974 report that the research and development (R&D) activities should be separated from the readiness functions. The current structure, with its emphasis on readiness, stifled RDA. As a result of this process the Communications-Electronics Command (CECOM) was established to handle the RDA process and the Communications-Electronics Readiness Command (CERCOM) took care of readiness. While this new structure gave RDA the enhanced visibility it needed, it also resulted in a duplication of administrative staffs.[54]

Unlike many Army-led reorganizations, the AMARC was not a one-time shot. "AMARC was an experiment, not a solution."[55] In August 1980, the committee again reviewed the RDA and readiness functions performed by CECOM and CERCOM respectively. The

committee found manpower reductions had taken their toll on the CERCOM and the duplication of effort had an adverse effect on the performance of both commands. Thus, in May 1981, the functions were brought together under the CECOM flag.[56]

In spite of the Army's efforts to reform the RDA process, little progress was made. By and large, the bureaucracy and extended time lines needed to field a materiel system still existed after the AMARC reorganizations.

The second series of reforms occurred in 1985 when President Regean established a Blue Ribbon Commission on Defense Management, the Packard Commission. The commission published its final report in 1986 making sweeping recommendations. In April 1986, National Security Decision Directive 219 implemented some of the recommendations. The Goldwater-Nichols Defense Reorganization Act of October 1986 directed further changes, as did the Defense Management Report in July 1989.[57]

These changes streamlined the acquisition process by removing a number of layers of bureaucracy. DOD developed an entire new set of implementing instructions and directives which consolidated literally hundreds of existing requirements into two key documents. The process outlined in Figure 1 is a product of this reform. The reorganization that stemmed from the Packard Commission's report made great strides in simplifying and codifying a system which had evolved over the past 50 years.

Unfortunately, even with the implemented changes the process still required 10-15 years to bring a system from need or concept to fielding. Even with the best designed system, funds are needed for procurement.

The Planning, Programming, and Budgeting System (PPBS) developed by McNamara is probably the most inflexible part of the process. The PPBS and the acquisition management system are two separate systems which must be coordinated and linked. Getting money into the budget takes from 3-4 years before it is available for execution and a PM must manage resources in 5-7 different budget years at any given time. If a program slips then the funds allocated may get pulled leaving the program's viability in question. If the funding stream and the program are not in sync then the program is normally restructured and extended.

Even with the turbulence in the RDA process, modernization did take place. At the corps level and below, the Signal Corps fielded the Army Area Communications System family of multichannel and carrier terminals. While these terminals were based on the transistor and printed circuit board, strides were made in the use of ICs. These in turn were followed by the Improved Army Tactical Communications System (IATCS). During the middle of this period there were at least five different generations of area communications systems fielded ranging from the Korean War vintage systems to the recently fielded IATCS.

The microprocessor permitted the development of programmable, semiautomatic telephone switches (SB-3614) that took up less space than the "plug" types they replaced. The first man-pack tactical single channel satellite terminals gave the commander a world-ranging C^2 capability (URC-101). The race was now on for smaller, reliable, more capable C^4 systems.

For the first time, a joint program office was established to develop C^4 systems. "The Army and its sister services developed interoperable telecommunications equipment through the Joint Tactical Communications Program (TRI-TAC)."[58] TRI-TAC equipment provided a common set of telephone (TTC-39) and message switching (TYC-39) equipment at echelons above corps (EAC). This equipment provided the interface between the tactical equipment at division and below and the commercial based systems used in the Defense Communications System (DCS).

At the beginning of the 1980s the concept of Airland Battle doctrine drove the need for an even more mobile, robust area communications system. However,

> the strength of the Signal Corps, already the largest single Army corps, was expected to grow. The general consensus was that our existing course to modernize tactical communications and to meet the mandates of Airland Battle was unaffordable in both manpower and dollars.[59]

The Vice Chief of Staff of the Army gave specific guidance to the Army leadership that the Signal Corps had to "get a greater capability with less people and fewer dollars."[60]

The study group assigned this dilemma proposed two options for what became known as Mobile Subscriber Equipment (MSE). The first alternative was built around a scaled-down version of the TRI-TAC equipment and the second on a non-developmental system. The second option offered greater savings in both manpower and money.[61]

As a non-developmental item, MSE broke the existing procurement mold. It pioneered a renaissance in creative materiel acquisition. The Army conducted a run-off between existing systems already developed by the British and French. The French RITA system won and the contract required delivery of the first systems within three years. In addition to updating the Army's common user area communications system, the Army regained about a division's worth of personnel in manpower savings.

The post Vietnam era was not without strife. The first of these conflicts, *Operation Urgent Fury*, took place in the fall of 1983. The second, *Operation Just Cause*, occurred at the close of 1989. Of the two, *Urgent Fury* had the larger impact on Command, Control, and Communications (C^3).

The Joint Chiefs of Staff issued the order to conduct *Urgent Fury* on the afternoon of Saturday, 22 October 1983. While Atlantic Command had the lead, the existing contingency plan, OPLAN 2360, was never used in the planning process. As a result,

existing command and control relationships were ignored and an entirely new plan was developed during the four days.[62]

From a materiel vantage, C^3 interoperability did exist but was doomed to failure by "the absence of a joint communications plan."[63]

Six years later, *Operation Just Cause* demonstrated what proper planning could accomplish. A coordinated, well-developed and rather simple C^3 plan was implemented during *Just Cause*.[64] Essentially the same C^3 systems used in Grenada were deployed to Panama. In the after action material "there has been no mention of major communications problems during *Just Cause* and certainly none of the kind noted in Grenada."[65]

POST COLD WAR

Whether you date the end of the Cold War to the fall of the Berlin Wall in 1989, NATO's July 1990 proclamation that Russia was no longer an adversary, or the dissolution of the Soviet Union as a nation-state in the fall of 1991; threats to our vital interests still existed. No longer was there a balance between superpowers to hold regional hegemons in check. The first of these to raise an ugly head was Iraq's Sadam Hussein when he flagrantly invaded Kuwait in August of 1990.

Units deployed to Southwest Asia (SWA) in support of the United Nations backed coalition went with what they had. This meant there were multiple generations of U.S. C^4 equipment

present.   In particular, the Army employed two VHF FM radio families in SWA: the 1960s vintage VRC-12/PRC-77 series and the partially fielded SINCGARS family.   Additionally, some units had MSE while others still had the Improved Army Tactical Communications System (IATCS) of the 1970s.[66]

During *Operations Desert Shield* and *Desert Storm*, three major factors affecting segments of the RDA process arose. Interoperability between cross generation systems posed a potential C^3 weakness.   Secondly, the availability of older generation equipment in sufficient quantity to fill unit requirements in lieu of newly authorized but unfielded systems caused concern.   These operations also brought civilian contractors in significant numbers to the theater of operations as part of the maintenance and support concept.

Army divisional units deployed with a combination of the newly issued MSE and the older IATCS family while at corps and above the TRI-TAC systems were employed.   As a cost reduction effort, the digital MSE system was not designed to work with the analog IATCS family.   This was a calculated risk the Army took in the procurement of MSE.   The key integrating factor that allowed the systems to work was TRI-TAC.   The TRI-TAC system had been designed with both analog and digital interfaces. It linked not only the dissimilar division systems together but also provided the connectivity back into the strategic and commercial networks.

This provided connectivity from the battlefield to the National Command Authority (NCA).

> It came as a surprise to many that such a mish-mash of products -- three generations of switching equipment and satellite systems which had never been designed to work with one another -- could work together as well as they did.[67]

The Army employed two different generations of VHF FM radio systems in SWA. Unlike the area communications systems, SINCGARS radios had been designed to interoperate with the VRC-12/PRC-77 series. However, interoperability was done at the expense of many of the advanced functions of SINCGARS. What did cause difficulties was the "fill of FM radios in units equipped with VRC-12/PRC-77 family was just sixty-five percent."[68] As units washed-out uneconomically repairable radios they did not reorder replacements, in an effort to conserve maintenance funds, betting on the fielding of SINCGARS. To fill unit shortages, the Army ordered the release of "6,160 [radios] from USAREUR theater reserves and POMCUS stocks and the diversion of 1,812 [radios] from those displaced by the fielding of SINCGARS in Korea."[69] While units did not want to waste limited maintenance funds on obsolete radio systems, they put themselves in a non-mission capable status (providing it was reported correctly). In light of the reduced threat of general war and unit status report indicators, the Army leadership should have considered filling unit requirements earlier. As part of the cradle-to-grave system management process, it would have been in the Army's best

interest to make these excess war stock radios available as free issue to units rather than go unused in a depot.

Desert Storm became the test case of taking civilian contractors to the battlefield. As part of the MSE and TRI-TAC maintenance plans, contractors were required to troubleshoot and fix systems in the theater of war.[70] The use of contractor-provided maintenance provided a means to reduce the number of uniformed personnel required to maintain a new system. Spaces saved through innovative concepts such as this are considered "plusses" in a PM's acquisition strategy. The concept did work and contractor support was invaluable.

Starting in mid-August 1992, the Army found itself involved in military operations other than war (MOOTW), as it facilitated humanitarian assistance to the civil war torn country of Somalia in *Operation Restore Hope*. From a RDA perspective, *Restore Hope* emphasized the need for systems that provided connectivity from the front-line to the NCA.[71] Flexibility of type and format of information being transmitted was critical. More than ever before, the demand for high capacity data circuits for logistics, electronic mail, and video was high. This was further exacerbated by the need of functional stovepipe systems which required separate data circuits.

> Time spent trying to learn and engineer just the (comparatively) few systems we were associated with during Restore Hope could have been better spent providing higher quality, overall service. Money spent

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on these circuits could have gone a long way to resolving our interoperability problems.[72]

Restore Hope offered a glimpse of C^4 requirements for future MOOTW operations. While supporting a relatively small force as compared to what was deployed to SWA during *Desert Storm*, *Restore Hope's* C^4 requirements were proportionally larger.

In December of 1995, *Operation Joint Endeavor* kicked off the implementation of the Dayton Peace Accords among the warring Serb, Croat, and Bosnian factions. *Joint Endeavor* reaffirmed the lessons of *Restore Hope*. The appetite for communications support was insatiable. As an example, over 400 Defense Switched Network (DSN) telephone trunks were extended back to Europe.

To meet this need, the Army rapidly procured COTS items and commercial services. The *Joint Endeavor* communications network from the start was a synthesis of commercial and military circuits. Commercially procured multiplexers permitted the transmission of VTC over military satellite systems. Similarly, commercial routers and hubs extended the unclassified MILNET from these same satellite systems. Concurrently, military intelligence circuits and DSN trunks were carried on leased commercial circuits. It was a fully integrated system.

A Herculean effort went into developing "black-boxes" and other methods for systems not designed to ride either the MILNET or dial up MSE telephone circuits. This exceptional effort was

done so that standard finance, personnel and logistical systems used in garrison could be used in a tactical environment.

Probably the greatest lesson learned out of the initial stages of *Joint Endeavor* was the need to develop C^4 systems to a commercial, open system standard.

At the conclusion of the Cold War and the reduced threat of conflict with Russia and her client states, the Congress and American public were looking for a peace dividend. A peace dividend that should come from a smaller, more lethal force as evidenced by the successful high-tech war with Iraq. The resultant smaller defense budgets were strained by current acquisitions and leave little room for new acquisitions.

While budget constraints are critical to new developments in support of the Army's Vision 2010 and the need for Information Dominance; the rate of technology change plays an even larger part in the future. With the turnover of information-related technology on an 18 to 24 month cycle, it is impossible to keep up or even establish a program baseline. In the past, the majority of the systems fielded have had technology that was at least a generation old. This happened because the materiel developer had to establish a baseline from which the system could be built. At the same time, technology was changing every 5-10 years. Thus, by the time you set your baseline and took from five to ten years to field your system it was about a generation

behind. With the rate of change today, a five to ten year development cycle puts you from five to seven generations behind.

THREADS OF CHANGE

During the course of the last 55-60 years, the acquisition process of C^4 equipment has supported the commander. It has been able to respond to the inputs of doctrine, technology, and user requirements. However, due to changes in the RDA system, the response time has increased from a matter of months in World War II to the current ten to twelve years.

The formal acquisition process for Army C^4 systems has evolved over time. In generic terms, the steps outlined in Figure 1 portray the technical development of C^4 systems whether in 1940 or the present. The difference lies in who is in charge of what steps and the order of the steps. As we look back over the preceding 55-60 years, what are the major changes that have taken place? And, will the current process support the needs of the Army in the future?

First, there was significantly less bureaucratic overhead both in the Army and in industry. From prior to World War II until the reorganization of the Army in 1962, the Signal Corps was responsible for the design and fielding of all communications equipment. If the warfighter had a specific requirement they came directly to the Signal Corps. The Signal Corps, in some respects, operated like a general contractor does now. They took

the requirement, did the development, if necessary, and then contracted it out either to a company they knew could do the work or by bid. The budgeting process was also less encumbered than now and gave the Signal Corps much more flexibility than does PPBS.

The McNamara reforms, while based on the best business practices of the period, seem to be the turning point in the growth in bureaucracy in the acquisition system. During this era many of the requirements that are now codified in the current acquisition system, such as a formal combat developments process, rigorous independent technical and operational testing, and more restrictive contracting procedures were implemented.

The reforms of the 1970s and 1980s were an attempt to simplify the process. The Packard Commission reforms did much to standardize acquisition across the Department of Defense by reducing the number of regulations and removing some of the administrative overhead. What it was unable to influence was the procurement timeline or the budget system.

Thus, until the acquisition process outlined in Figure 1 is reengineered, progress in meeting the challenges of 21st century C^4 will not be met. A simpler, less complex development process must be instituted if the Army is going to achieve Information Dominance on the future battle field as proscribed in *Army Vision 2010*.

THE FUTURE

The Army's Force XXI Advanced Warfighting Experiment (AWE) is a prime example of a possible solution to this dilemma. This program leverages commercial technology, a modified budget process, and uses an experimental approach to development.

> Under the umbrella of the Joint Venture program, the Army brought together developers from Training and Doctrine Command, combat soldiers from Forces Command, acquisition officials from Army Material Command, program executive officers and program managers from various weapons systems and technology programs, and industry technicians to form a team.[73]

Experimentation by this team of experts allows the Army a "try before you buy" approach to acquisition. This iterative or spiral development process allows for continuous feed back, concurrent testing, and product enhancement throughout the accelerated development process.[74]

Although the regulations governing the acquisition process have not changed, Congress has authorized and funded a Rapid Acquisition Program for AWE and the Force XXI systems.[75] This process should dramatically reduce the time to field the digital battlefield.

In the words of Army Chief of Staff General Dennis J.

Reimer,

> This is a success story because we cut off years in terms of cycle time to identify requirements and field the right piece of equipment. This is executing acquisition reform, not just talking about it. The key was the team concept that we put together involving combat developers, material developers, testers and users.[76]

(Word Count: 8960)

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